REMARKS

Claims 1-4 are pending in the subject application. Claim 1 has been amended herein. Claim 5 is added. Support for the amendment to claim 1 and for added claim 5 is found throughout the Specification and claims, as filed, and no new matter is presented by the amendment.

Favorable reconsideration in light of the remarks which follow is respectfully requested.

1. Drawings

The drawings have been objected to under 37 CFR 1.84(p)(5) because "they include the following reference sign(s) not mentioned in the description: 14 and 30."

Applicants have amended the specification as required. Support for the amendment is found throughout the Specification and Figures, as filed, and no new matter is presented by the amendment. Reconsideration and withdrawal of the objection is respectfully requested.

2. 35 U.S.C. §102 Rejections

Mabuchi et al.

Claim 1 has been rejected under 35 U.S.C. §102(b) as being anticipated by Mabuchi et al (US Patent No. 5,646,644). The Office asserts that:

> Mabuchi et al teach a plasma processing apparatus (Fig. 10A) comprising:
> a reaction chamber 1 (*a process chamber for processing by means of plasma*);
> a waveguide 23 and a dielectric sheet 21 (*microwave transmission means for transmitting microwave to said process chamber*);
> a microwave window 4 (*a dielectric for radiating the microwave transmitted by said microwave transmission means into said process chamber*); and
> a window support member 5 having openings 6 formed in the shape of slit with the intention of improving the uniformity of plasma (*a slot antenna plate formed of conductor, placed on a side, facing said process chamber, of said dielectric, and including an opening for passing the microwave therethrough radiated from said dielectric*) (column 5, lines 28-64 and column 8, lines 33-51).

Applicants respectfully traverse.

Applicants claim, in claim 1, a plasma processing apparatus comprising a process chamber for processing by means of plasma; a microwave transmission means for transmitting microwave to said process chamber; a dielectric for radiating the microwave transmitted by said microwave transmission means into said process chamber; and a slot antenna plate formed of conductor, placed on a side, facing said process chamber, of said dielectric, and including an opening for passing the microwave therethrough radiated from said dielectric. According to Applicants, the opening of the slot antenna has a longer side with its length equal to half the space wavelength of the dielectric.

Applicants have found that for a microwave-excited plasma processing apparatus, a microwave circuit should be regarded as a resonator. Further, the resonator includes the portion of the apparatus where microwave enters a vacuum chamber. Accordingly, a plasma processing apparatus should be designed so as to consider propagation characteristics of the microwave regarding the microwave entrance portion in terms of start and maintenance of plasma discharge by low power as well as plasma uniformity.

Applicants further found that by contacting the slot antenna plate directly with the dielectric, they were able to shorten a space wavelength of microwave compared to that when an air layer is present between the slot antenna plate and the dielectric. Consequently, the intervals between openings in the slot antenna plate can be shortened so that a greater number of openings are formed. The microwave radiated into the process chamber through the openings is, thus, distributed uniformly in the process chamber. (See page 4, lines 9-15)

Applicants found that microwave radiation can be efficiently and uniformly radiated from slots 7a by designing the slot antenna plate 7 to function as a slot antenna for microwave. In other words, the slots 7a are positioned directly below the antinode of the standing wave to efficiently radiate microwave into chamber interior 13. Further, Applicants found that by forming the opening of the slot antenna so as to

have longer side with its length equal to half the space wavelength of the dielectric, improved results are obtained. In particular, Applicants have found that by forming the slot antenna openings so as to have lengths of the longer sides equal to half of the space wavelength in the dielectric, superior radiation characteristics are achieved. The present invention takes advantage of the superior radiation characteristics of the slot antenna to enhance the uniformity of plasma for a large-sized substrate as well as the uniformity of the process.

Thus, in accordance with one embodiment, Applicants plasma processing apparatus

> includes as main components a chamber lid 1, a process chamber body 2, a waveguide 3, an entrance waveguide 3a, a first dielectric 4, a second dielectric 5, a support member 6, a slot antenna plate 7, and a substrate holder. (page 6, lines 2-6; Figs 1-3).

As set out by Applicants,

> Under the second dielectrics 5, slot antenna plate 7 made of conductor is fixed to contact the second dielectrics 5.
>
> Support member 6 made of conductor is fastened around the second dielectrics 5 and slot antenna plate 7 with screws for example as shown in Fig. 3 for supporting the second dielectrics 5 and slot antenna plate 7 on chamber lid 1. (Page 7, lines 6-12)

In accordance with a second embodiment,

> a plasma processing apparatus as shown in Fig. 6 is structured without the second dielectric to extend a first dielectric 4 in the direction of the shorter side (direction in which the waveguide extends). Then, a slot antenna plate 7 contacts the first dielectric. A support member 6 supports slot antenna plate 7 only. (page 11, lines 17-21)

In accordance with a third embodiment,

> Slot antenna plate 7 is not supported by the support member as employed in the first and second embodiments, but fixed directly to chamber lid 1 with screws for example. (page 12, lines 22-27; Figs. 7 and 8)

Applicants' found that they could significantly improve the properties of the plasma processing apparatus by altering the design of the slots 7a in the slot antenna plate 7:

> Slot 7a is rectangular for example. Then, slot 7a is designed to have the longer side with a half length of the space wavelength in the dielectric (e.g. approximately 20 mm provided that the dielectric has a relative dielectric constant of 10 and the frequency is 2.45 GHz) and to have the shorter side which is one-half or less of the longer side in length. Usually, the radiation efficiency of the microwave is enhanced when the longer side of the rectangular slot of the slot antenna is $2/\lambda$. Slot 7a can be shaped in this way to enhance the radiation efficiency of the microwave.
>
> Preferably, the shape of slot 7a is varied depending on the size of the standing-wave distribution. Specifically, the longer side of slot 7a is made shorter where the field amplitude is large. Depending on the position of slot 7a, the amount of microwave radiation could vary. Therefore, a slot 7a of a greater radiation amount has its longer side which is shortened for decreasing the radiation amount in order to radiate the same amount of microwave as that from other slots. Accordingly, microwave radiation from slots 7a can be rendered uniform.
>
> The slots 7a are thus designed to allow slot antenna plate 7 to function as a slot antenna for microwave which can efficiently and uniformly be radiated from slots 7a.
>
> It is noted that slots 7a are designed with the number and shape according to the structure of a resonator. In other words, any design may be employed on the condition that the microwave is radiated uniformly from slots 7a. For example, rectangular slots 7a may be different in length and width as described above, or the central axis of slot 7a may be declined with respect to the longitudinal side of the slot antenna plate.

(Page 7, line 32 – page 8, line 20)

The Mabuchi reference describes a plasma processing apparatus including a dielectric sheet 21, a space 20 beneath the dielectric sheet, a microwave window 4 below the space 20, and a window supporting member 5 beneath the microwave window 4. According to Mabuchi, the microwave propagated in the dielectric sheet 21 forms an electric field in a space 20 beneath it. This electric field penetrates a microwave window 4 and enters a reaction chamber 1. (See col. 1, lines 28-40).

Thus, Mabuchi merely describes a window supporting member 5 that supports the microwave window 4. Contrary to the Office's assertion, the window supporting member 5 is <u>not</u> a slot antenna plate in accordance with Applicants' invention. As set forth above, Applicants' plasma processing apparatus includes one or two dielectric 4/5, a slot antenna plate 7 formed on the first dielectric 4 (in the case of a single

dielectric) or on the second dielectric 5 (in the case of two dielectrics) and a support member 6 which supports the dielectric 4/5 and the slot antenna plate 7. Thus, According to Applicants' disclosure, the slot antenna plate 7 and the support member 6 are two separate and different elements.

Mabuchi only describes a dielectric sheet 21, a microwave window 4, and a window supporting member 5 which supports the microwave window. Mabuchi does not describe or suggest a slot antenna plate in addition to these elements, as taught by Applicants.

Further, even if the window support member 5 of Mabuchi could possibly be considered a "slot antenna plate", Mabuchi does not describe or suggest a slot antenna having openings designed such that the length of the longer side of the openings is equal to half of the space wavelength in the dielectric. Rather, Mabuchi merely describes slit-like openings 6. Applicants respectfully submit that the slit-like openings 6 do not serve as slots of a slot antenna as taught by the present invention. Rather, the slit-like openings are merely microwave-inlet windows through which microwave passes to enter the vacuum chamber.

As provided in MPEP-2131, a claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. *Verdegal Bros. v. Union Oil Co. of California*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Or stated another way, "The identical invention must be shown in as complete detail as is contained in the ... claims. *Richardson v Suziki Motor Co.*, 868 F.2d 1226, 9 USPQ 2d. 1913, 1920 (Fed. Cir. 1989). Although identify of terminology is not required, the elements must be arranged as required by the claim. *In re Bond*, 15 USPQ2d 1566 (Fed. Cir. 1990).

It is clear from the foregoing remarks that each and every element of Applicants' claim 1 is not described by the Mabuchi reference. Reconsideration and withdrawal of the rejection is respectfully requested. Claims 2-5 depend from claim 1 and, likewise, are not anticipated by the Mabuchi reference.

Katayama et al.

Claims 1, 3 and 4 have been rejected under 35 U.S.C. §102(b) as being anticipated by Katayama et al (US Patent No. 5,545,258). The Office asserts that:

> Katayama et al teach a plasma processing apparatus (Fig. 3) comprising:
>
> a reaction chamber 21 (*a process chamber for processing by means of plasma*);
>
> a waveguide 6 and a dielectric sheet 4 (*microwave transmission means for transmitting microwave to said process chamber*);
>
> a microwave introducing window 5 (*a dielectric for radiating the microwave transmitted by said microwave transmission means into said process chamber*); and
>
> a metal plate 11 having slit-like microwave transmission holes 12 as shown in Figs. 4A, 4B (*a slot antenna plate formed of conductor, placed on a side, facing said process chamber, of said dielectric, and including an opening for passing the microwave therethrough radiated from said dielectric*) (column 6, line 38 through column 8, line 8).
>
> *Further regarding claims 3:* the metal plate 11 serves as anode which is confronted with a cathode (sample holder 2a), the metal plate 11 is connected to ground via the reactor 1 (column 7, lines 1-13 and lines 59-63).
>
> *Further regarding claims 4:* the metal plate 11 further includes a large number of small holes 13 through which process gases are introduced into the chamber (column 7, lines 40-58).

Applicants respectfully traverse.

As set forth above, Applicants found that by forming a plasma processing apparatus which includes a slot antenna having openings that are formed so as to have longer sides with lengths equal to half the space wavelength of the dielectric, improved results are obtained. In particular, Applicants have found that by forming the slot antenna having openings with a length of the longer side equal to half of the space wavelength in the dielectric, superior radiation characteristics are achieved. The present invention takes advantage of the superior radiation characteristics of the slot antenna to enhance the uniformity of plasma for a large-sized substrate as well as the uniformity of the process.

Katayama describes a microwave plasma processing system that includes a metal plate 11 having "slit-like microwave transmission holes 12." (Col. 7, lines 44-46) "[M]icrowaves are introduced into the reaction chamber 21 via the microwave introduction window 5 and the microwave transmission holes 12." (Col. 7, lines 65-67)

However, Katayama does not describe or suggest a plasma processing apparatus which includes a slot antenna having openings that are formed so as to have longer sides with lengths equal to half the space wavelength of the dielectric as taught by Applicants. Rather, Katayama merely describes a metal plate 11 having slit-like microwave transmission holes 12. Applicants respectfully submit that the slit-like microwave transmission holes 12 do not serve as slots of a slot antenna as taught by the present invention. Rather, the slit-holes are merely microwave-inlet windows through which microwave passes to enter the vacuum chamber.

Thus, it is clear from the foregoing remarks that each and every element of Applicants' claim 1 is not described by the Katayama reference. Reconsideration and withdrawal of the rejection is respectfully requested. Claims 2-5 depend from claim 1 and, likewise, are not anticipated by the Katayama reference.

3. 35 U.S.C. §013 Rejections

Mabuchi et al.

Claims 2 and 4 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Mabuchi et al (US Patent No. 5,645,644). The Office asserts that:

> Mabuchi et al in Fig 10A teach all limitations of the claims as discussed above except for the window support member 5 (slot antenna plate) including a channel for process gas.
>
> Mabuchi et al further in Fig 7A teach that the window support member 5 may include gas inlets 41 provided in the beams 5b for improving the uniformity of plasma (column 7, lines 41-46).
>
> Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to implement the gas inlets as taught in Fig. 7A in the apparatus of Fig. 10A in order to improve the uniformity of plasma.
>
> *Further regarding claim 2:* arrangement of the openings of the window support member (slot antenna plate) with respect to the location

of the antinodes of a standing wave is considered to have been obvious to one of ordinary skill in the art at the time of invention as Mabuchi et al further teach that the electric field in each slit opening 6 is intensified (column 8, lines 42-51).

Applicants respectfully traverse for the reasons set forth above.

Namely, Mabuchi et al describes a plasma processing apparatus including a dielectric sheet 21, a space 20 beneath the dielectric sheet, a microwave window 4 below the space 20, and a window supporting member 5 beneath the microwave window 4. According to Mabuchi et al, the microwave propagated in the dielectric sheet 21 forms an electric field in a space 20 beneath it. This electric field penetrates a microwave window 4 and enters a reaction chamber 1. (See col. 1, lines 28-40).

Thus, Mabuchi et al describes a window supporting member 5 that supports the microwave window 4. Contrary to the Office's assertion, the window supporting member 5 is not a slot antenna plate in accordance with Applicants' invention. Applicants' plasma processing apparatus includes one or two dielectric 4/5, a slot antenna plate 7 formed on the first dielectric 4 (in the case of a single dielectric) or on the second dielectric 5 (in the case of two dielectrics) and a support member 6 which supports the dielectric 4/5 and the slot antenna plate 7. Thus, according to Applicants, the slot antenna plate 7 and the support member 6 are two separate and different elements. Mabuchi only describes a dielectric sheet 21, a microwave window 4, and a window supporting member 5 which supports the microwave window. Mabuchi does not describe or suggest a slot antenna plate as taught by Applicants.

Further, even if the window supporting member could possibly be considered to be a "slot antenna plate", Mabuchi does not describe or suggest a plasma processing apparatus which includes a slot antenna plate having openings that are formed so as to have longer sides with lengths equal to half the space wavelength of the dielectric as taught by Applicants. Rather, Mabuchi merely describes slit-like openings 6 in the window supporting member. Applicants respectfully submit that the slit-like openings 6 do not serve as slots of a slot antenna as taught by the present invention. Rather,

the slit-like openings are merely microwave-inlet windows through which microwave passes to enter the vacuum chamber.

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). MPEP 2142.

As set forth above, Mabuchi clearly does not teach or suggest all the claim limitations. Further, there is absolutely no motivation provided by the reference to modify Mabuchi as taught by Applicants. This motivation comes purely from Applicants' disclosure. Thus, claim 1 is patentable over Mabuchi. Claims 2-4 depend from claim 1 and, likewise, are patentable over Mabuchi.

Katayama et al.

Claim 2 has been rejected under 35 U.S.C. §103(a) as being unpatentable over Katayama et al (US Patent No. 5,545,258). The Office asserts that:

> Katayama et al teach all limitations of the claims as discussed above except for the explicit disclosure of the arrangement of the openings 12 of the metal plate 11 (slot antenna plate) with respect to the location of the antinode of a standing wave.
>
> Arrangement of the openings 12 in the metal plate 11 with the antinode of standing wave is considered to have been obvious to one of ordinary skill in the art at the time of invention via routine optimization in order to allow transmission of microwave through openings more efficiently.

Applicants respectfully traverse for the reasons set forth above. In particular, Katayama does not describe or suggest a plasma processing apparatus which includes a slot antenna having openings that are formed so as to have longer sides with lengths equal to half the space wavelength of the dielectric as taught by Applicants. Rather,

Katayama merely describes a metal plate 11 having slit-like microwave transmission holes 12. Applicants respectfully submit that the slit-like microwave transmission holes 12 do not serve as slots of a slot antenna as taught by the present invention. Rather, the slit-holes are merely microwave-inlet windows through which microwave passes to enter the vacuum chamber.

Applicants have found that microwave radiation can be efficiently and uniformly radiated from slots 7a by designing the slot antenna plate 7 to function as a slot antenna for microwave. In other words, the slots 7a are positioned directly below the antinode of the standing wave to efficiently radiate microwave into chamber interior 13. This can be accomplished in a number of ways by providing various sized and shaped slots positioned precisely below the antinode of the standing wave. Further, Applicants found that by forming the opening of the slot antenna so as to have longer side with its length equal to half the space wavelength of the dielectric, improved results are obtained. In particular, Applicants have found that by forming the slot antenna openings so as to have lengths of the longer sides equal to half of the space wavelength in the dielectric, superior radiation characteristics are achieved. The present invention takes advantage of the superior radiation characteristics of the slot antenna to enhance the uniformity of plasma for a large-sized substrate as well as the uniformity of the process.

The Office acknowledges that Katayama et al does not disclose arrangement of the openings 12 of the metal plate 11 (slot antenna plate) with respect to the location of the antinode of a standing wave. However, the Office asserts that it would have been obvious to do this to via routine optimization in order to allow transmission of microwave through openings more efficiently.

Applicants respectfully disagree.

As the Federal circuit has stated, "[t]he mere fact that the prior art may be modified in the manner suggested by the Examiner does not make the modification obvious unless the prior art suggested the desirability of the modification." *In re Fritch*, 972 F.2d 1260,1266, 23 USPQ2d 1780, 1783-84 (Fed. Cir. 1992). Obviousness may

not be established using hindsight or in view of the teachings or suggestions of the inventor. *Para-Ordance Mfg. v. SGS Importers Int'l, Inc.*, 73 F.2d 1085, 1087, 37 USPQ2d 1237, 1239 (Fed. Cir. 1995).

There is absolutely no motivation provided by the reference to modify Katayama as proposed by the Office. This motivation comes purely from Applicants' disclosure. Further, there is absolutely no motivation to modify Katayama so as to have slots shaped as taught by Applicants. This motivation comes purely from Applicants' disclosure.

It is well established that a particular parameter must first be recognized as a result-effective variable, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges of said variable might be characterized as routine experimentation. *In re Antonie,* 559 F.2d 618, 195 USPQ 6 (CCPA 1977); MPEP §2144.05.

In this case, there is no description or suggestion, absent Applicants' disclosure, that arrangement of the openings in relation to the location of the antinode of a standing achieves any recognized result. Further, there is no description or suggestion, absent Applicants' disclosure, that the shapes and sizes of the openings with relation to the space wavelength of the dielectric achieves any recognized result. Thus, determination of size, shape and positioning, of the openings cannot be characterized as routine experimentation.

Accordingly, Applicants respectfully submit that claim 1, and all claims dependent therefrom, are patentable over Katayama.

CONCLUSION

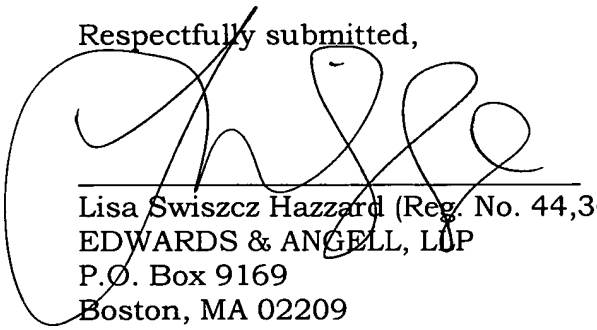
In light of the above amendments, Applicant respectfully requests early consideration and allowance of the subject application.

Applicants believe that additional fees are not required in connection with the consideration of the within matter. However, if for any reason a fee is required, a fee

paid is inadequate or credit is owed for any excess fee paid, you are hereby authorized and requested to charge Deposit Account No. **04-1105.**

Should the Examiner wish to discuss any of the amendments and/or remarks made herein, the undersigned attorney would appreciate the opportunity to do so.

Respectfully submitted,



Lisa Swiszcz Hazzard (Reg. No. 44,368)
EDWARDS & ANGELL, LLP
P.O. Box 9169
Boston, MA 02209
Tel. No. (617) 517-5512